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Dark matter map reveals galaxy cluster's appetite

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Astronomers have created the first detailed map of dark matter in a cluster of galaxies. The map indicates that such clusters grow by swallowing individual galaxies, as well as providing a timely reality check for cosmological theories of dark matter.

The galaxy cluster studied, CL0024+1654, is one of the largest structures in the Universe. It is 4.5 billion light years away and, although too faint to be seen with the naked eye, spans an area of sky as large as the full Moon.

Like all clusters, 80 to 85 per cent of its mass must be in a form of "invisible" dark matter, which does not emit radiation and is only detectable by its gravitational interaction with visible objects.

The astronomers used the Hubble Space Telescope to probe 39 regions of the cluster, but focused on galaxies located far behind the cluster. This was to detect for the subtle warping that the gravitational field of the cluster itself induces on the images of the more distant galaxies.

This phenomenon, known as weak gravitational lensing, allowed the team to deduce the way mass, and hence dark matter, is distributed across a swathe of the cluster spanning more than 20 million light years.

Cold or hot

Jean-Paul Kneib, at the Observatoire Midi-Pyrénées, France, presented the international team's results on Thursday at the International Astronomical Union's general assembly in Sydney, Australia.

"There has been quite a debate about the shape of galaxy cluster mass profiles and no previous observations had given a clear cut preference," he told **New Scientist**. "This is the first time we can differentiate between different profiles with such confidence."

The results show that, in general, the mass profile decreases sharply towards the edges of the cluster - in good agreement with the predictions of cold dark matter theory. This assumes that dark matter is mostly heavy, slow-moving particles, known as WIMPS (weakly-interacting massive particles), that easily clump together, rather than hot, fast moving particles like neutrinos.

Fully digested

They also saw good evidence that the cluster is still growing, by swallowing galaxies. Once a galaxy has been fully 'digested', its dark matter will be spread out, contributing to the overall mass profile.

Yet in CL0024+1654, some of the outlying galaxies are still associated with their own clumps of dark matter, indicating that they are at an early stage of this process.

The observations of CL0024+1654 clocked up 120 hours of observing time, an unprecedented amount of HST time for the study of a single galaxy cluster. However, the results have been so encouraging that the team have been granted even more time to extend the work.

The results have been accepted for publication in *The Astrophysical Journal*.

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